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ABSTRACT

This document is the student workbook for a course in mathematics for water quality control personnel. This version contains complete problems, answers and references. Problems are arranged alphabetically by treatment process. Charts, graphs, and drawings represent data forms an operator might see in a plant containing information necessary for performing the calculations required. Treatment processes covered include: (1) an aerobic digestion; (2) effluent disposal; (3) grit removal; (4) primary sedimentation; (5) sand filtration; (6) sedimentation; and (7) trickling filter. (CS)

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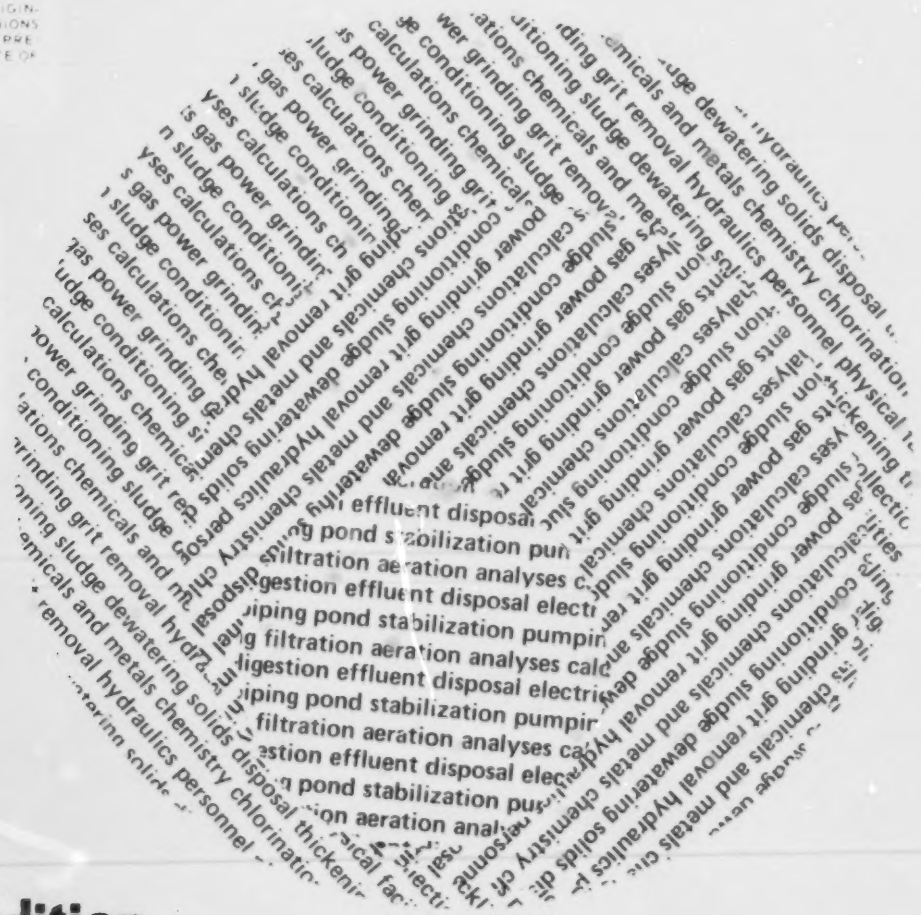

Second Edition

MATH PROBLEMS FOR WATER QUALITY CONTROL PERSONNEL

Student Workbook

2

SE 026 867

MATH PROBLEMS
For Water Quality Control Personnel
Second Edition

Fred Delvecchio
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Environmental Systems Engineering
Clemson University
Clemson, South Carolina

1977

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Preface

In many instructional programs for water quality control personnel, mathematics proves to be one of the most difficult courses for the student. Failure rates are high, relevant problems are difficult and instructors are at a loss when trying to apply mathematical principles to the water quality control field. This edition of Math Problems for Water Quality Control Personnel will assist the mathematics instructor with little experience in the field, the technical instructor with field experience lacking confidence as a mathematics instructor and the operator with a need to improve his or her mathematical skills.

For the first edition, the authors reviewed 54 manuals now used in instructional programs and found that design problems are used to train and test operators. Since operators do not need to master such mathematical calculations, the authors turned from standard references and to active operators to find problems reflecting day-to-day mathematical demands placed on plant personnel. This second edition is the result of operators' contributions to the first edition.

The authors have tried to present the problems in this edition using data as it appears in the treatment plant. Consequently, the number of words in each problem statement has been held to a minimum. To every possible extent, efforts have been made to eliminate the "storybook approach" to problems because such an approach does not produce an accurate representation of how an operator sees information in a plant.

Editing, organization and production of this manual was ably provided by Jack A. McKenzie, editor; Clay Duffie, illustrator; Marie Sims and Patsy Phillips, typists. Other valuable assistance was provided by Clemson University and its publications staff and Tom Hallman. The 77 problems contained in this book were selected by the authors after more than 1500 such items had been reviewed. A loose-leaf version of the chosen problems was prepared and field tested in a mathematics workshop sponsored by Clemson University's Office of Operator Training. Following this validation procedure, the final copy of the manual was done and sent to the printers. Keith Hoy and Andy Young gave significant assistance by proofing all the final problems for correct answers. The biggest thanks of all, however, must go to the numerous operators who submitted problems in response to the first edition.

Introduction

The manual before you is but one of two forms in which the second edition of Math Problems for Water Quality Control Personnel has been prepared. This is the workbook version containing complete problems, answered and referenced as explained in the instructions on page vi. The workbook has been designed for the operator wishing to study on his or her own and for the instructor wanting an easy-to-use reference or textbook.

The second form, the instructor's manual, has any number of uses. The manual includes only problem statements; no data or answers are given. An instructor needing outlines for problems to assign as classroom work or to include on examinations can select the problems he or she wants and fill in appropriate data. Under this system, an instructor can develop unlimited variations for any given problem. The same is true for certification boards looking for models for examination questions. A third potential user of the incomplete form is the plant supervisor faced with presenting on-the-job training programs. Since the supervisor would be familiar with the calculations required for operation of his or her plant and would have access to actual plant data, he or she could easily produce a mathematics training program specifically oriented to that plant.

Any comments or suggestions for improving this manual or corrections in the text will be appreciated. Also, should the reader think of any problems that should be added, the authors ask that such items be put into the format used in the manual and mailed to Fred Delvecchio, Project Administrator, 401 Rhodes Engineering Research Center, Clemson University, Clemson, South Carolina 29631.

Instructions

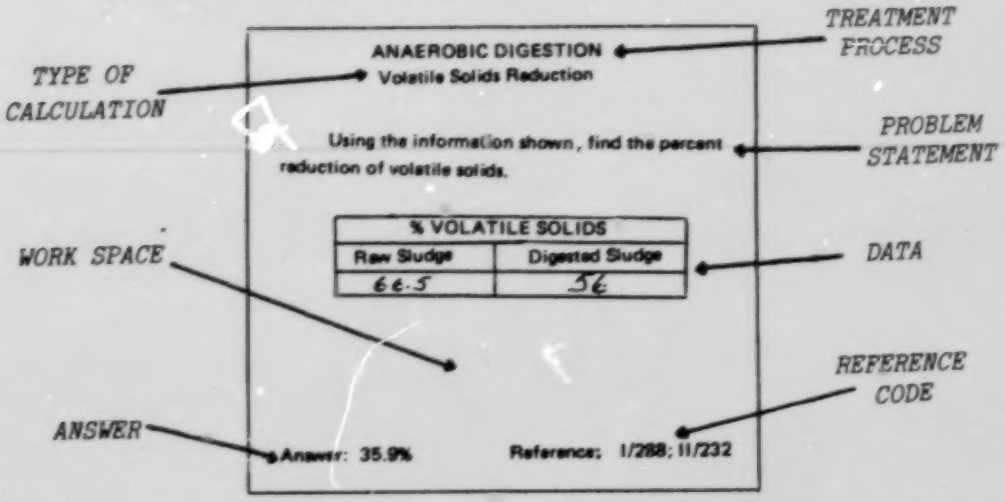
The problems in the text are arranged alphabetically by treatment process. Subheads clue the student as to what type calculations are required to work the problem. Charts, graphs and/or drawings representing data forms the operator might see in a plant contain information necessary for performing the calculations required by the problems. The back of each page has been left blank to supplement the work space provided on the front. In the bottom left of each page is the correct answer to the problem on that page.

In the bottom right corner of each page is a coded reference keyed to the two-volume resource chosen by the authors. The resource is Mathematics for Water and Wastewater Treatment Plant Operators, Book I -- Fundamentals and Book 2 -- Advanced, by Joanne Kirkpatrick, State Water Resources Board, Sacramento, California. The books (copyright 1973) were published by Ann Arbor Science Publishers, Incorporated, Post Office Box 1425, Ann Arbor, Michigan 48106.

The reference code works as follows.

I/260 means Book 1/Page Number 260
II/205 means Book 2/Page Number 205

A sample problem page is presented below.



ACTIVATED SLUDGE

Air Requirement

Each pound of BOD going into an aerator needs 1000 cubic feet of air. Using this and the information shown, find the cubic feet of air required daily. Then find the cubic feet of air per minute required from the blowers.

Flow mgd	BOD mg/ℓ
2.2	168

Answer: 3,082,464 cubic feet/day
2,141 cubic feet/min

Reference: I/260; II/205

ACTIVATED SLUDGE

Air Requirement

Using the information shown, find the cubic feet of air applied for each pound of BOD.

FLOW mgd	PRI EFF BOD mg/ℓ	Air Flow x 1000 cu. ft./day
1.0	120	900

Answer: 899.28 cu ft/lb BOD

Reference: I/260; II/205

ACTIVATED SLUDGE

Food/Organism Loading Ratio

Using the information shown, find the food/organism loading ratio.

FLOW mgd	PRI EFF BOD mg/ℓ	MLVSS mg/ℓ	AERATOR VOL. gals.
2.5	200	2000	625,000

Answer: 0.4

Reference: I/233; II/173

ACTIVATED SLUDGE

Food/Organism Ratio

Using the information shown, find the food/organism ratio.

FLOW mgd	PRI EFF BOD mg/ℓ	MLSS mg/ℓ	MLVSS %	AERATOR VOL. gals.
1.0	140	2000	80	250,000

Answer: 0.35

Reference: I/233; II/173

ACTIVATED SLUDGE

Mean Cell Residence Time

Using the information shown, find the mean cell residence time. The aerator holds 1.25 million gallons and the final clarifier holds 0.09 million gallons.

Suspended Solids mg/ℓ			Flow mgd	
Fin Eff	Waste Sludge	MLSS	Plant	Waste
12	6540	3680	4.1	.072

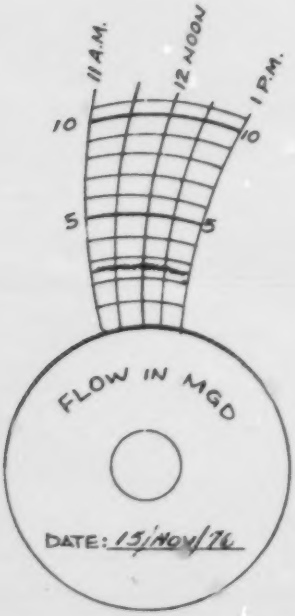
Answer: 9.48 days

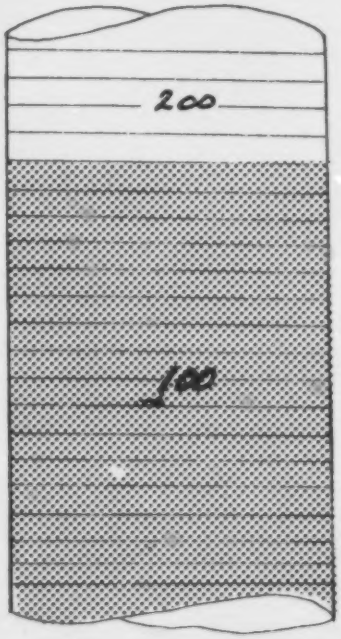
Reference: I/244; II/182

ACTIVATED SLUDGE

Return Sludge Pumping Rate

Using the information shown, find the return sludge pumping rate in gallons per minute.





1000 mℓ

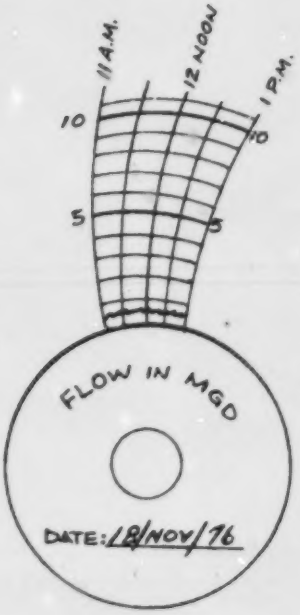
Answer: 312.5 gpm

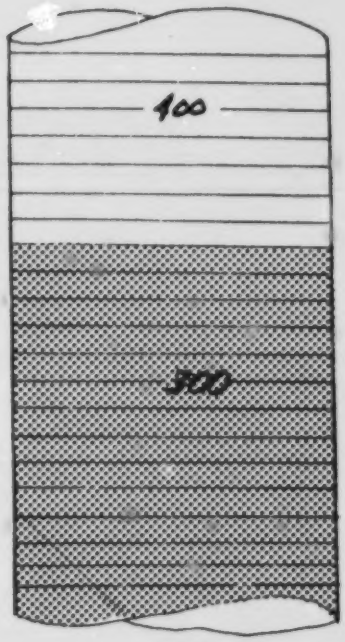
Reference: I/255; II/199

ACTIVATED SLUDGE

Return Sludge Pumping Rate

Using the information shown, find the return sludge pumping rate in million gallons per day.





2000 mℓ

Answer: 0.0875 mgd

Reference: I/255; II/199

ACTIVATED SLUDGE

Sludge Age

Using the information shown, find the sludge age in days for an aeration tank holding 200,000 gallons.

FLOW mgd	PRI EFF SS mg/ℓ	MLSS mg/ℓ
1.8	115	2000

Answer: 1.93 days

Reference: I/239; II/177

ACTIVATED SLUDGE

Waste Sludge Pumping Rate

Using the information shown, find the waste sludge pumping rate in gallons per day.

RETURN SLUDGE mg/ℓ	WASTE SLUDGE lb/day
5000	2000

Answer: 47,962 gallons/day

Reference: I/252; II/195

ACTIVATED SLUDGE

Waste Sludge Pumping Rate

Using the information shown, find the waste sludge pumping rate in gallons per minute.

Waste Sludge		Remarks
mg/ℓ	lb/day	
6000	3000	Waste sludge pump running 25 minutes/hour

Answer: 100 gpm

Reference: I/252; II/195

ANAEROBIC DIGESTION

Detention Time

Find the detention time in days for the raw sludge fed to the digester shown.

Raw Sludge
122,030 gpd

Volume 500,000 cu. ft.

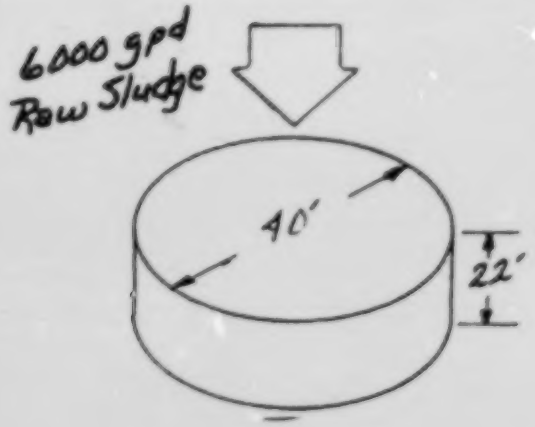
Answer: 30.7 days

Reference: I/285; II/229

ANAEROBIC DIGESTION

Detention Time

Find the detention time in days for the raw sludge fed to the digester shown.



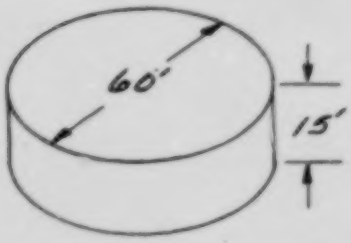
Answer: 34.54 days

Reference: I/285; II/229

ANAEROBIC DIGESTION

Digester Loading

Using the information shown, find the pounds of volatile solids added per cubic foot of digester volume each day.



DIGESTER		
Raw Sludge gallons	% Solids total	% Solids volatile
30,000	5	70

Answer: .21 lbs VS/cu ft

Reference: I/281; II/225

ANAEROBIC DIGESTION

Gas Production

Using the information shown, find the cubic feet of gas produced for each pound of volatile solids destroyed.

DIGESTER				
Raw Sludge gallons	% Solids total	% Solids volatile	Gas Produced cu ft	Volatile Solids reduction
8000	5	70	12,840	55%

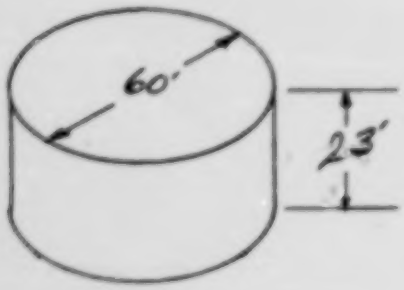
Answer: 10 cu ft/lb VS

Reference: I/294; II/234

ANAEROBIC DIGESTION

Seed Sludge Volume

Find the gallons of seed sludge needed to fill the digester shown to 35 percent of its volume.



Answer: 170,620 gallons

Reference: I/275

ANAEROBIC DIGESTION
Seeding

You want to maintain a volatile-solids-loading ratio of 0.05 pounds of seed volatile solids for each pound of volatile solids under digestion. Find the pounds of volatile solids the seed sludge should have under these conditions.

DIGESTER		
Raw Sludge gallons	% Solids total	% Solids volatile
1500	6	50

Answer: 7506 lbs

Reference: I/276; II/221

ANAEROBIC DIGESTION
Volatile Solids Loading

A 500,000-gallon digester seems to operate best with a volatile solids loading of 0.3 pounds per day per cubic foot. Using the information shown, find how many gallons of raw sludge can be pumped to this digester daily.

RAW SLUDGE	
% Solids total	% Solids volatile
8	80

Answer: 37,470 gallons/day

Reference: I/281; II/225

ANAEROBIC DIGESTION
Volatile Solids Reduction

Using the information shown, find the percent reduction of volatile solids.

% VOLATILE SOLIDS	
Raw Sludge	Digested Sludge
66.5	56

Answer: 35.9%

Reference: I/288; II/232

ANAEROBIC DIGESTION
Volatile Solids Reduction

Using the information shown, find the pounds of volatile solids destroyed each day.

DIGESTER			
Raw Sludge gallons	% Solids total	% Solids volatile	% Reduction volatile solids
8000	4	65	55

Answer: 954 lbs

Reference: I/282; II/227

ANAEROBIC DIGESTION

Volatile Solids Reduction

Using the information shown, find the pounds of volatile solids destroyed for each cubic foot of a digester with a volume of 20,000 cubic feet.

DIGESTER			
Raw Sludge gallons	% Solids total	% Solids volatile	% Reduction volatile solids
2400	5	71	50

Answer: .018 lbs/cu ft/day

Reference: I/283; II/227

ANALYSES

BOD, Milligrams per Liter

Using the information in the laboratory worksheet shown, find the BOD, milligrams per liter for the raw, primary effluent and final effluent samples.

BOD				
Sample	Blank	Raw	Primary Effluent	Final Effluent
Bottle number	63	72	87	89
mℓ Sample	0.0	6.0	12.0	48.0
Initial DO mg/ℓ	7.9	7.8	7.7	7.6
5 Day DO mg/ℓ	7.9	2.3	2.8	3.2

BOTTLE VOLUME = 300 mℓ

Answers: Raw 275 mg/ℓ
Primary Effluent 122.5 mg/ℓ
Final Effluent 27.5 mg/ℓ

Reference: I/340; II/257

ANALYSES

BOD, Percent Dilution

Using the information in the latoratory worksheet shown, find the percent dilution of the blank, raw, primary effluent and final effluent samples.

BOD				
Sample	Blank	Raw	Primary Effluent	Final Effluent
Bottle number	63	72	87	89
mℓ Sample	0	6	12	48

BOTTLE VOLUME = 300 mℓ

Answers:

Blank	0%
Raw	2%
Primary Effluent	4%
Final Effluent	16%

Reference: I/340; II/257

ANALYSES

BOD Removal

Using the information in the laboratory worksheet shown, find the efficiency of the primary and secondary treatment processes and the overall plant efficiency.

BOD				
Sample	Blank	Raw	Primary Effluent	Final Effluent
Bottle number	63	72	87	89
mℓ Sample	0.0	6.0	12.0	48.0
Initial DO mg/ℓ	7.9	7.8	7.7	7.6
5 Day DO mg/ℓ	7.9	2.3	2.8	3.2

BOTTLE VOLUME = 300 mℓ

Answers: Primary Efficiency 55%
Secondary Efficiency 78%
Overall Plant Efficiency 90%

Reference: I/203; II/134

ANALYSES

Expressing Concentration

Write mixed-liquor-suspended-solids concentration of 0.25 percent as milligrams per liter.

Answer: 2500 mg/ℓ

Reference: II/251

ANALYSES

Expressing Concentration

Write a total-solids concentration of 10,000 milligrams per liter as a percent.

Answer: 1%

Reference: I/251

ANALYSES

Expressing Temperature

Change the temperature shown on the celsius thermometer to the corresponding temperature in Fahrenheit.

Answer: 93 degrees F

Reference: I/321

ANALYSES

Expressing Temperature

Change the temperature shown on the Fahrenheit thermometer to the corresponding temperature in celsius.

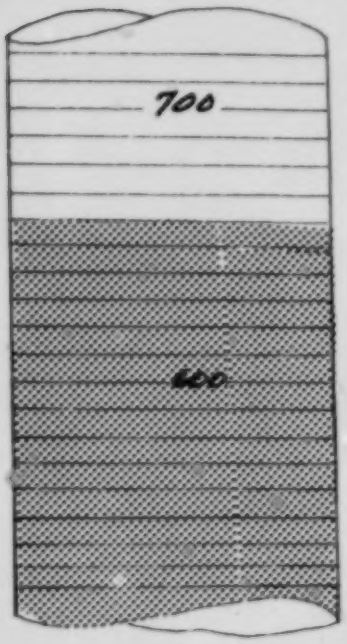
Answer: 21 degrees C

Reference: I/321

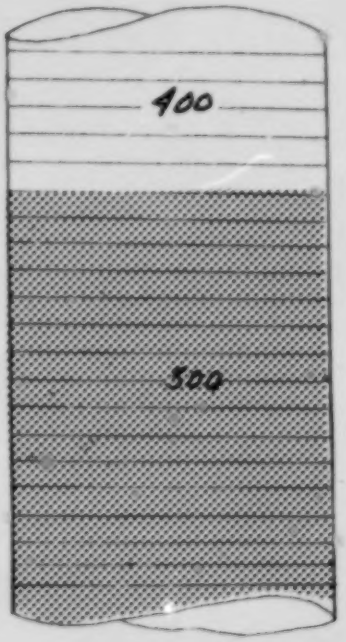
ANALYSES

Settleability

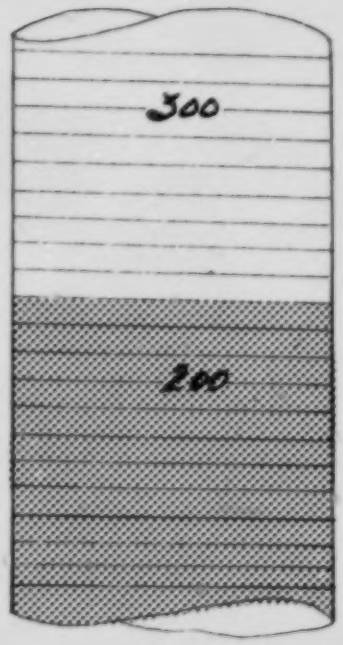
A one-liter sample of mixed liquor settled to the levels shown. Find the percent of settled sludge for each time given.



1000 mℓ
5 min.



1000 mℓ
15 min.



1000 mℓ
60 min.

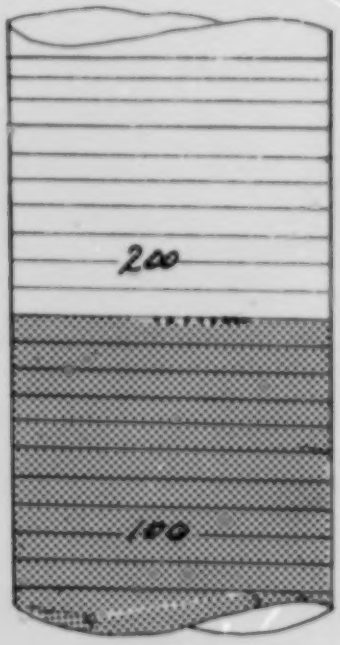
Answer: 5 minutes 66%
15 minutes 37%
60 minutes 23%

Reference: I/333; II/252

ANALYSES

Sludge Density Index

A one-liter sample of mixed liquor settled to the level shown. Find the sludge density index if the mixed liquor suspended solids are 2000 milligrams per liter.



1000 mℓ
30 min.

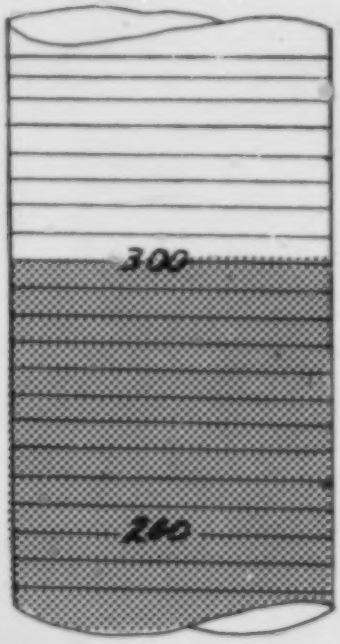
Answer: 1.11

Reference: I/339; II/255

ANALYSES

Sludge Volume Index

A one-liter sample of mixed liquor settled to the level shown. Find the sludge volume index if the mixed liquor suspended solids are 3000 milligrams per liter.



1000 mℓ
30 min.

Answer: SVI = 100

Reference: I/335; II/253

ANALYSES

Suspended Solids, Milligrams Per Liter

Using the information in the laboratory worksheet shown, find the milligrams per liter suspended solids.

SUSPENDED SOLIDS	
Sample	Primary Effluent
Crucible number	36
mℓ Sample	50
Dry weight in grams	34.5550
Tare weight in grams	34.3328

Answer: 4444 mg/ℓ

Reference: I/329

ANALYSES

Suspended Solids, Percent Volatile

Using the information in the laboratory worksheet shown, find the percent volatile suspended solids.

SUSPENDED SOLIDS	
Sample	Primary Effluent
Crucible number	27
mℓ Sample	100
Dry weight in grams	16.3725
Tare weight in grams	16.3646
Ash weight in grams	16.3667
Tare weight in grams	16.3646

Answer: 73.41%

Reference: II/332

ANALYSES

Total Solids, Percent

Using the information in the laboratory worksheet shown, find the percent total solids.

TOTAL SOLIDS	
Sample	Raw
Dish number	14
Wet weight in grams	97.25
Tare weight in grams	37.25
Dry weight in grams	40.50
Tare weight in grams	37.25

Answer: 5.42%

Reference: I/324

ANALYSES

Volatile Acid/Alkalinity Ratio

Using the information the laboratory worksheet shown, find the volatile acid/alkalinity ratio.

DIGESTER	
Volatile Acids mg/ℓ	Alkalinity mg/ℓ
140	1760

Answer: .08

Reference: I/284; II/228

ANALYSES

Volatile Solids, Percent

Using the information in the laboratory worksheet shown, find the percent volatile solids.

VOLATILE SOLIDS	
Sample	Raw
Dish number	14
Dry weight in grams	40.50
Tare weight in grams	37.25
Ash weight in grams	39.50
Tare weight in grams	37.25

Answer: 30.8%

Reference: I/324

CHLORINATION

Chlorine Demand

Using the information shown, find the chlorine demand in milligrams per liter.

CHLORINATION		
Cl2 Feed lbs/day	Flow mgd	Cl2 Residual mg/ℓ
70	1.2	0.4

Answer: 6.59 mg/ℓ

Reference: I/306; II/241

CHLORINATION

Chlorine Demand Satisfied

The chlorine demand of a wastewater effluent is 12 milligrams per liter. After chlorination, the chlorine demand is still 2 milligrams per liter. Find the percent of the chlorine demand satisfied.

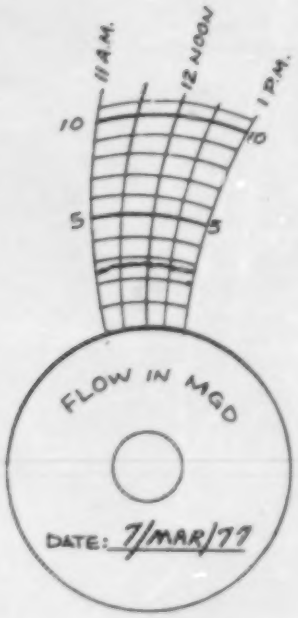
Answer: 83.3%

Reference: I/312; II/241

CHLORINATION

Chlorine Dosage

You must apply 5 milligrams per liter of chlorine. Find the pounds per day of chlorine needed.



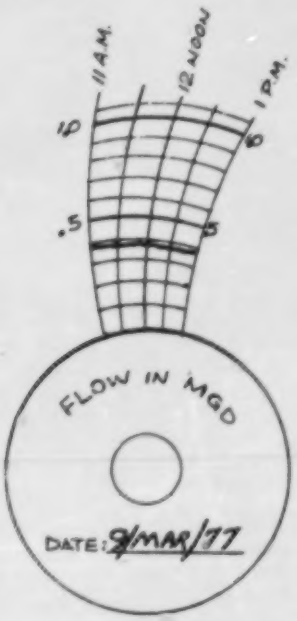
Answer: 104.25 lb/day

Reference: I/302; II/241

CHLORINATION

Chlorine Feed Rates

You must apply 10 milligrams per liter of chlorine. Find the feed rate on the chlorinator in pounds per day.



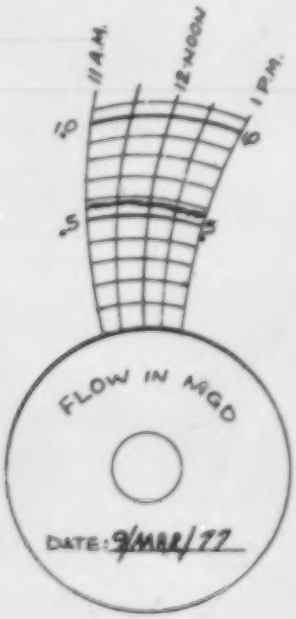
Answer: 30.9 lbs/day

Reference: I/302; II/241

CHLORINATION
Hypochlorination

You want to apply 5 milligrams per liter of chlorine. Using the information shown, find the pounds of calcium hypochlorite needed each day.

Net Weight 100 lb	
Active Ingredient: Calcium Hypochlorite*	62%
Inert Ingredients	38%
*Available Chlorine	62%



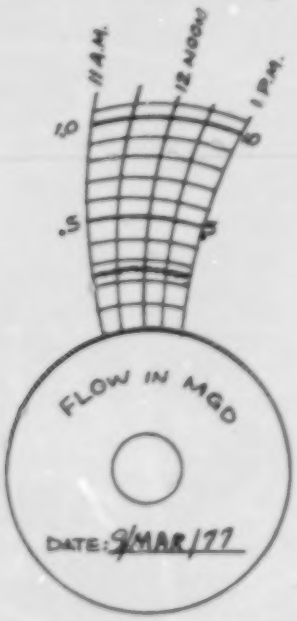
Answer: 36.99 lbs

Reference: I/309; II/241

CHLORINATION
Hypochlorination

Find the pounds of hypochlorite used each day to give a 12 milligrams per liter dosage of chlorine to a plant flow shown below.

Net Weight 100 lb	
Active Ingredient: Calcium Hypochlorite*	70%
Inert Ingredients	30%
*Available Chlorine	70%



Answer: 35.74 lbs

Reference: I/302; II/241

EFFLUENT DISPOSAL
Stream Dilution

A wastewater effluent with the flow and BOD_5 recorded in the report form shown flows into a stream. The stream has a flow of 50 million gallons per day and BOD_5 of 8 milligrams per liter. Find the BOD_5 in milligrams per liter of the combined stream and wastewater effluent flows.

EFFLUENT	
Flow mgd	BOD mg/ℓ
2.1	36

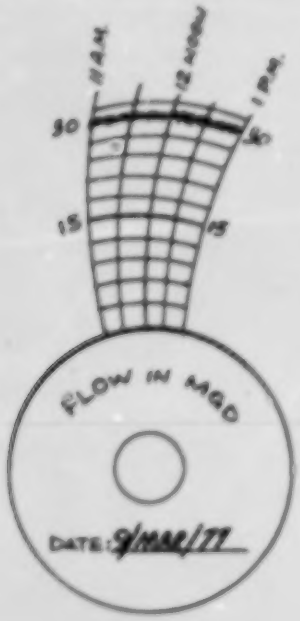
Answer: 9.3 mg/ℓ

Reference: I/317; II/247

FLOW MEASUREMENT

Flow Composition

The flow chart shown indicates the average flow of a plant getting 3.2 cubic feet per second of industrial waste from a cannery. Find the percent of the plant's daily flow from the cannery.

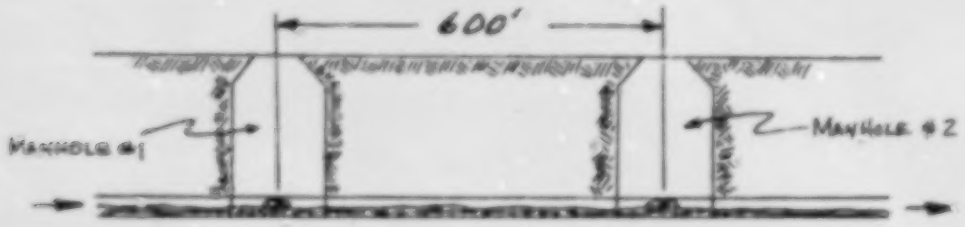


Answer: 7%

Reference: I/140; II/50

FLOW MEASUREMENT
Flow Velocity

At 9:45 a.m. you dropped a float into one manhole shown. At 9:50 a.m. the float reached the other manhole. Using the information shown, find the velocity of flow in feet per second.



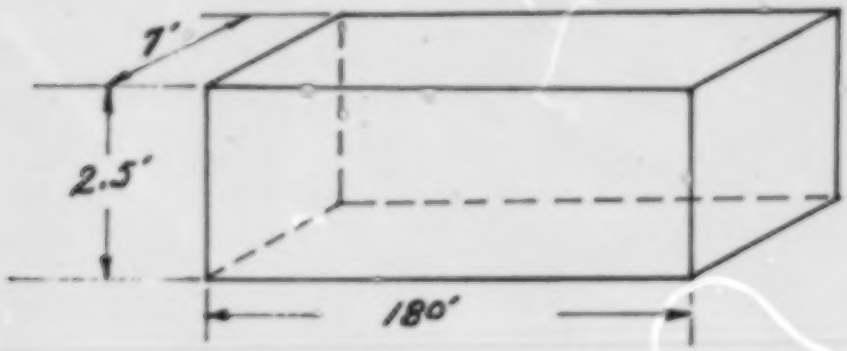
Answer: 2 ft/sec

Reference: I/143; II/62

FLOW MEASUREMENT

Open Channel Flow

Assume the plant flow meter is broken and you have to calculate the influent flow for plant records. A small stick you drop into the inlet channel floats the distance shown in 30 seconds. Find the plant flow in million gallons per day.



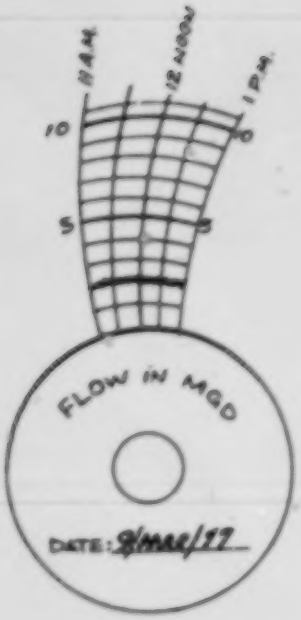
Answer: 68 mgd

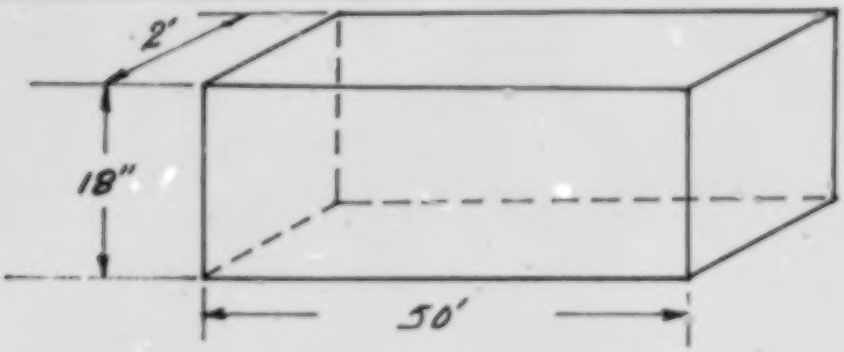
Reference: I/129; II/27

GRIT REMOVAL

Flow Velocity

Find the flow in feet per second through the grit chamber shown.





Answer: 1.03 ft/sec

Reference: I/177; II/105

GRIT REMOVAL

Flow Velocity

A small stick dropped into the wastestream entering a grit chamber floats 15 feet in 20 seconds. Find the velocity of the wastewater in feet per second.

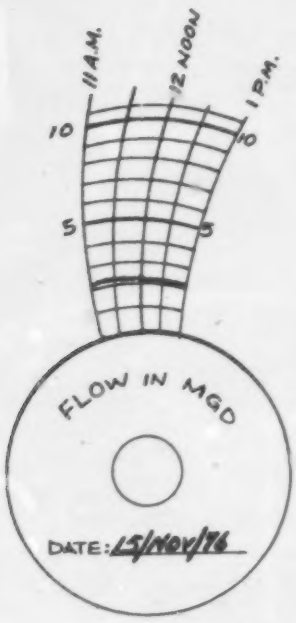
Answer: .75 ft/sec

Reference: I/177; II/105

GRIT REMOVAL

Volume of Grit Removed

In 24 hours, a cart holding 2.6 cubic feet of grit is used to haul two and one-half loads. Find the cubic feet of grit removed per million gallons per day.



Answer: 3.09 cu ft/million gallons/day Reference: I/187; II/117

POPULATION EQUIVALENT
BOD

An industry contributes 1.5 million gallons per day of an industrial waste with a BOD of 600 milligrams per liter. Assuming 0.17 pounds BOD per day per capital, find the population equivalent of this waste.

Answer: 44,153 people

Reference: I/173; II/100

POPULATION EQUIVALENT
Suspended Solids

A wastewater treatment plant receives 850,000 gallons per day from an industry with suspended solids of 200 milligrams per liter. Assuming 0.22 pounds suspended solids per day per capita, find the population equivalent of this waste.

Answer: 6,445 people

Reference: I/173; II/100

PRIMARY SEDIMENTATION

Pumping Schedules

Using the information shown, find the minutes the raw sludge pump must run each day. The pump capacity is 60 gallons per minute.

RAW SLUDGE PUMPED	
Gallons	Solids %
12,600	6

Answer: 210 minutes/day

Reference: I/213

PRIMARY SEDIMENTATION

Sludge Pumping

Using the information shown, find the gallons of raw sludge that must be pumped to remove all the solids from the sedimentation tank.

RAW SLUDGE PUMPED	
Solids lbs	Solids %
5170	5

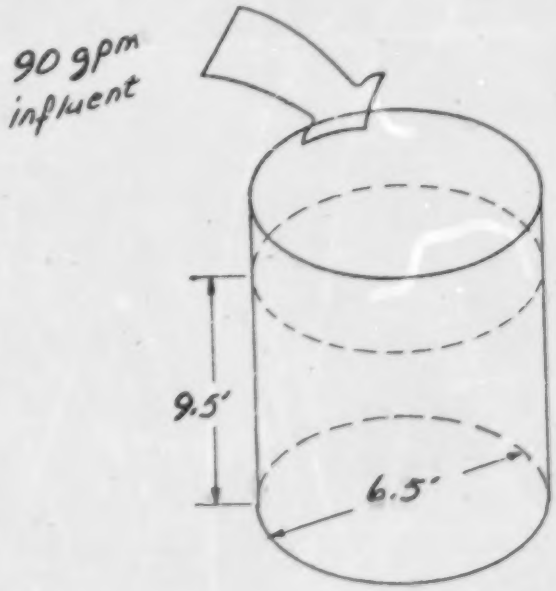
Answer: 12,398 gallons

Reference: I/263; II/209

PUMPING STATIONS

Pump Capacity

The pump starts when the wastewater reaches a level of 9.5 feet and stops when the level drops to 2.8 feet. It takes 12 minutes to pump this amount of wastewater from the wet well. Find the capacity of the pump if the influent flow rate to the wet well is 90 gpm.



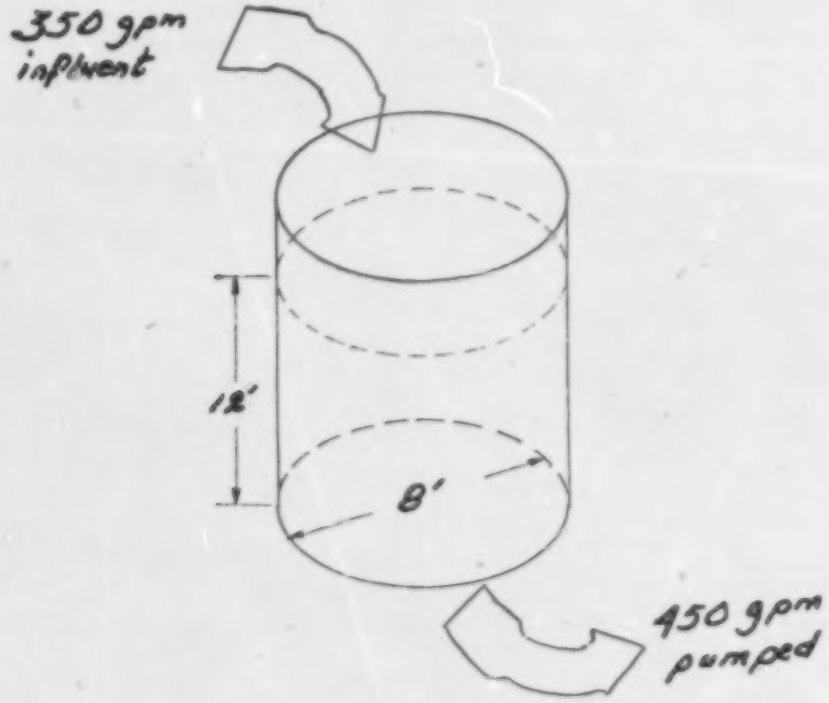
Answer: 229 gpm

Reference: I/153; II/71

PUMPING STATIONS

Pumping Rate

Wastewater is entering the wet well at the rate of 350 gpm. If the pump can deliver 450 gpm, how long will it take to empty the full wet well?



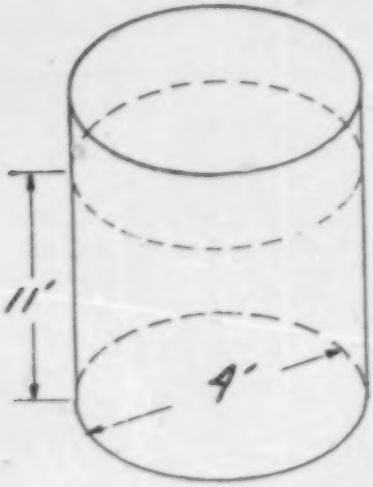
Answer: 45.2 minutes

Reference: I/101, 153; II/71

PUMPING STATIONS

Wet Well Capacity

What is the capacity of the wet well in gallons?

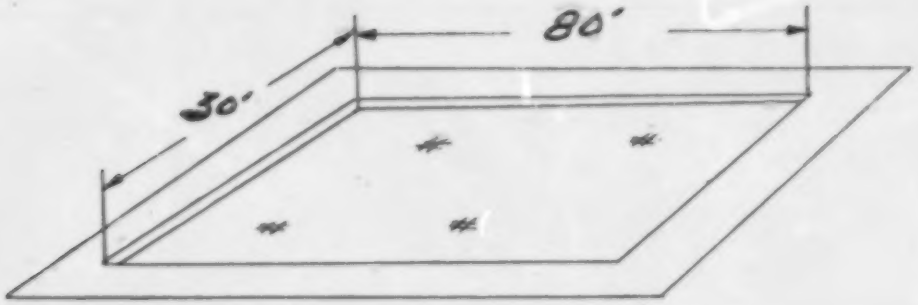


Answer: 1,036.2 gallons

Reference: I/101

SAND FILTRATION
Cleaning Filter

Find the cubic feet of air required to clean the sand filter shown if 3 cubic feet of air are needed for each square foot of filter surface area.



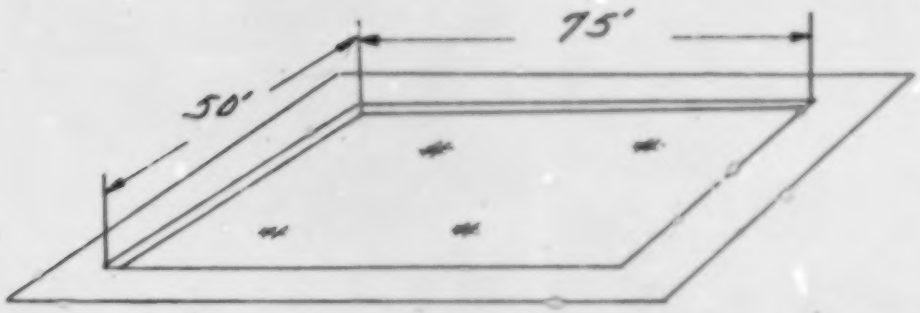
Answer: 7,200 cubic feet

Reference: I/314; II/246

SAND FILTRATION

Dosage

Find the dosage in gallons per hour per square foot to the rapid sand filter shown. The average daily flow is 5.0 million gallons per day.



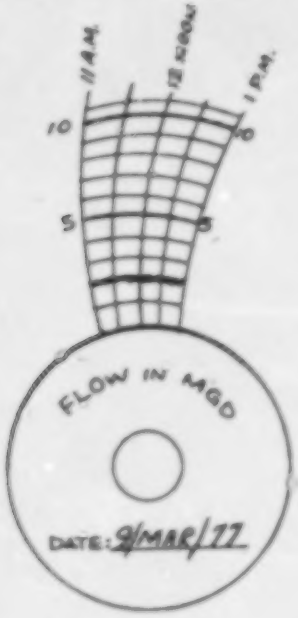
Answer: 55.5 gph/sq ft

Reference: I/314; II/246

SCREENING

Screenings Disposal

A treatment plant with an average flow as shown below removes an average of 1.7 cubic feet of screenings per million gallons of flow. The screenings are disposed of at a landfill. Estimate the landfill volume needed in cubic feet for a year.



Answer: 1241 cubic feet

Reference: I/175; II/101

SCREENING

Volume of Screenings

Using the information shown, find the volume of screenings removed per million gallons of flow.

FLOW mgd	SCREENINGS cu ft
4.4	11

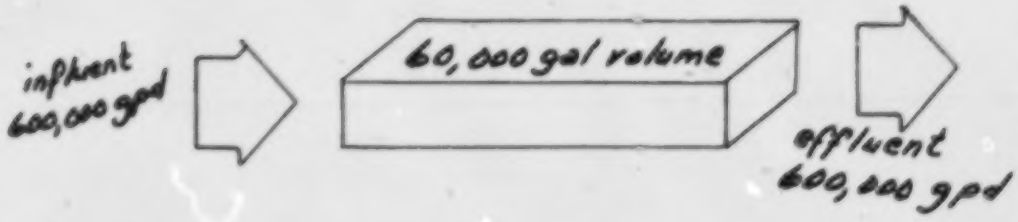
Answer: 2.5 cu ft/million gallons

Reference: I/175; II/101

SEDIMENTATION

Detention Time

Find the detention time in hours for the sedimentation tank shown.



Answer: 2.4 hours

Reference: I/193; II/125

SEDIMENTATION

Efficiency, BOD Removal

Using the information shown, find the percent of BOD removed by the sedimentation tank.

Raw BOD mg/ℓ	Primary Effluent BOD - mg/ℓ
307	215

Answer: 30%

Reference: I/202; II/134

SEDIMENTATION

Efficiency, BOD Removal

Using the information shown, find the pounds of BOD removed in the primary clarifier.

Flow mgd	5 Day BOD		
	Influent mg/ℓ	Effluent mg/ℓ	Removal %
3	265	159	40

Answer: 2652 lbs

Reference: I/205; II/139

SEDIMENTATION

Efficiency, Suspended Solids Removal

Using the information shown, find the efficiency of the sedimentation tank in removing suspended solids.

Raw Suspended Solids mg/ℓ	Effluent Suspended Solids mg/ℓ
250	100

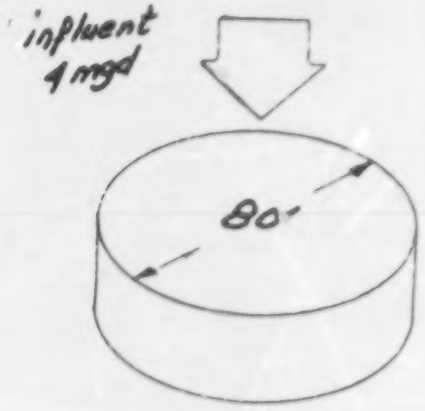
Answer: 60%

Reference: I/202; II/134

SEDIMENTATION

Surface Loading Rate

Find the surface loading rate in gallons per day per square foot for the sedimentation tank shown.



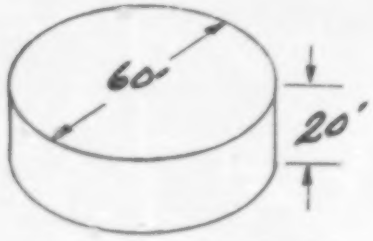
Answer: 796 gpd/sq ft

Reference: I/190; II/122

SEDIMENTATION

Tank Volume

Find the volume in million gallons of the clarifier shown.



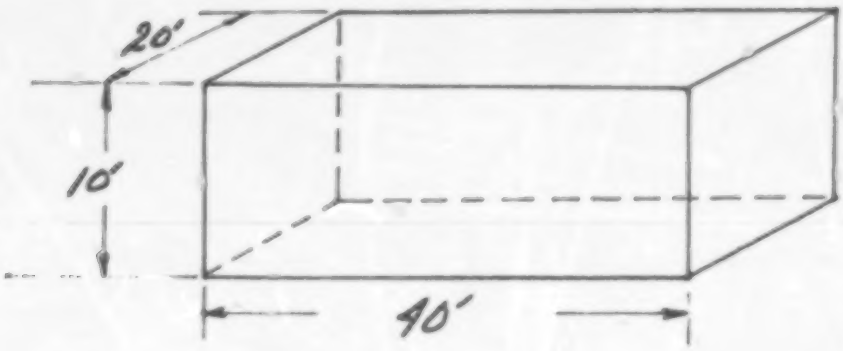
Answer: 0.4239 Million gallons

Reference: I/189; II/119

SEDIMENTATION

Tank Volume

Find the volume in gallons of the clarifier shown.



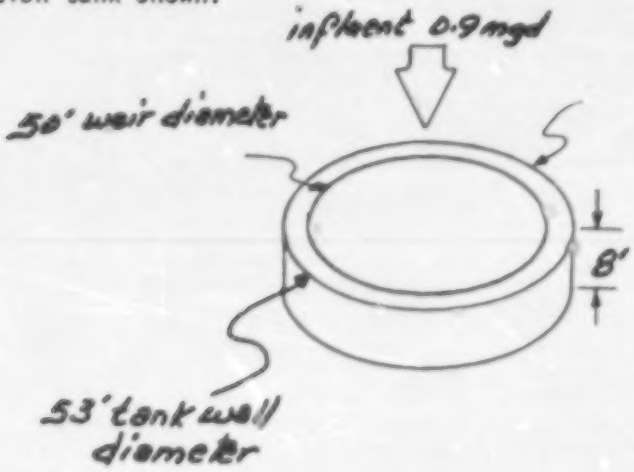
Answer: 60,000 gallons

Reference: I/189; II/119

SEDIMENTATION

Weir Overflow Rate

Find the weir overflow rate in gallons per day per foot of the sedimentation tank shown.



Answer: 5733 gpd/ft

Reference: I/199; II/131

THICKENING
Sludge Pumping

Using the information shown, find the gallons of thickened sludge that must be pumped to the digester from the thickener to move the 9800 pounds of solids.

RAW SLUDGE PUMPED		THICKENED SLUDGE PUMPED
Solids lbs	Solids %	Solids %
9800	4.2	6.4

Answer: 18,360 gallons

Reference: I/267; II/212

TRICKLING FILTER

BOD Removal

Using the information shown, find the pounds of BOD removed by the trickling filter each day.

FLOW mgd	INFLUENT BOD mg/ℓ	PRIMARY SEDIMENTATION % BOD Removal	TRICKLING FILTER % BOD Removal
12	300	25	85

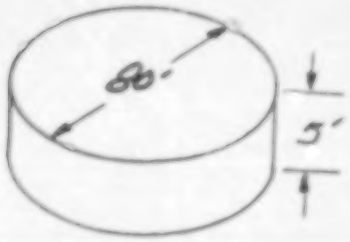
Answer: 19,140 lbs

Reference: I/231; II/170

TRICKLING FILTER

Filter Capacity

Find the volume in acre-feet of the trickling filter shown.

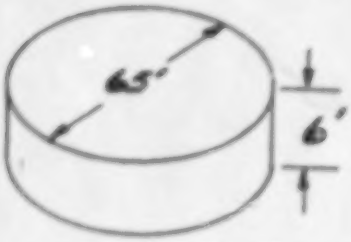


Answer: 0.577 acre-feet

Reference: I/221; II/152

TRICKLING FILTER
Filter Capacity

Find the volume in cubic feet of the trickling filter shown.

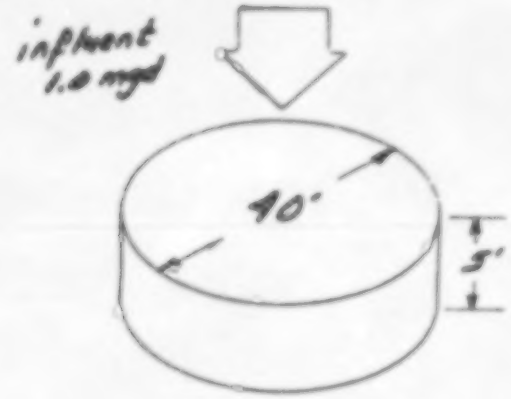


Answer: 19,899.75 ft^3

Reference: I/221; II/152

TRICKLING FILTER
Hydraulic Loading

Find the hydraulic loading value in gallons per day per square foot of the trickling filter shown.

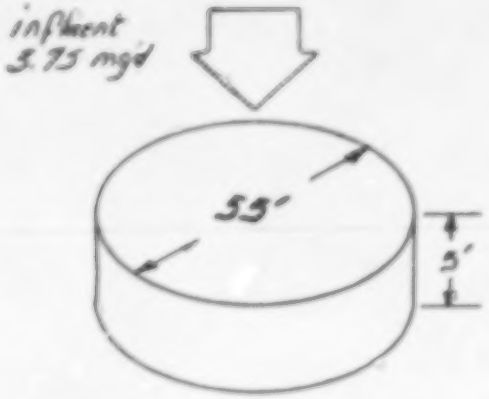


Answer: 796 gpd/ft^2

Reference: I/225; II/156

TRICKLING FILTER
Hydraulic Loading

Find the hydraulic loading value in million gallons per acre per day of the trickling filter shown.



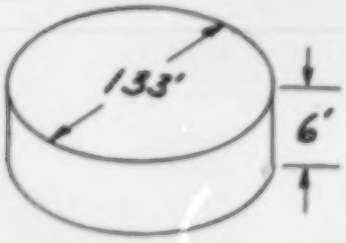
Answer: 68.8 mil-gal/acre/day

Reference: I/225; II/159

TRICKLING FILTER
Organic Loading

Using the information shown for the trickling filter, find the organic loading value, in pounds BOD per day per 1000 feet cubed.

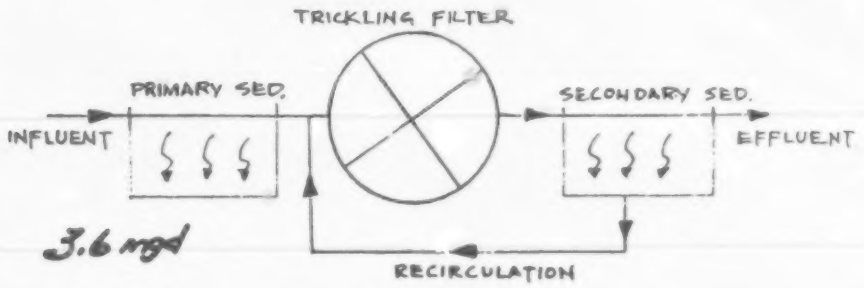
FLOW mgd	INFLUENT BOD mg/ℓ
2.5	200



Answer: 50.1 lb BOD/day/1000 ft^3 Reference: I/229; II/164

TRICKLING FILTER
Recirculation Flow

Find the recirculation flow in million gallons per day of the trickling filter plant shown. The recirculation ratio is 0.39

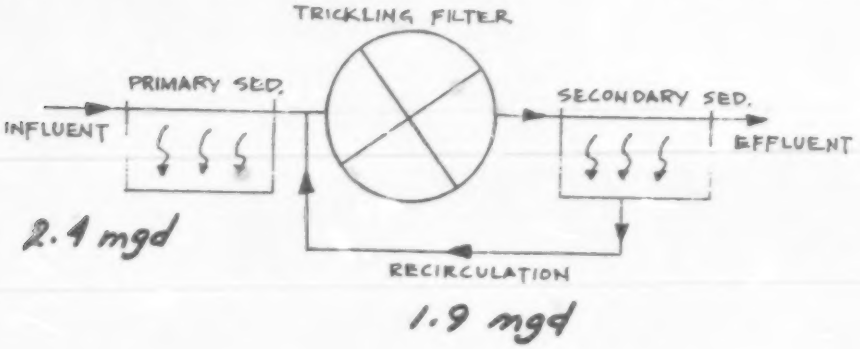


Answer: 1.404 mgd

Reference: I/223; II/154

TRICKLING FILTER
Recirculation Ratio

Find the recirculation ratio of the trickling filter plant shown.



Answer: 0.79

Reference: I/223; II/154

TRICKLING FILTER

Suspended Solids Removal

Using the information shown, find the pounds of suspended solids removed by the trickling filter each day.

FLOW mgd	INFLUENT Suspended Solids mg/ℓ	PRIMARY SEDIMENTATION Suspended Solids % Removal	TRICKLING FILTER Suspended Solids % Removal
5	200	60	80

Answer: 2,668.8 lb

Reference: I/231; II/170